

## ARSET

Applied Remote Sensing Training

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# Overview of Digital Elevation from Shuttle Radar Topography Mission (SRTM) and Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)

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# Learning Objectives

By the end of this presentation, you will be able to:

- Understand SRTM and ASTER Digital Elevation Modeling (DEM) data
- Access DEM for Flood Management Applications

# Outline

- Overview of SRTM and ASTER DEM Data
- SRTM and ASTER DEM Data Access
  - Global Data Explorer (GDEx)
  - Consultative Group for International Agricultural Research (CIGAR)
- Demonstration of GDEx

The background is a topographic map showing a river system. The river is dark blue and winds through a landscape of green and brown terrain. A semi-transparent white rectangular box is centered over the map, containing the title text. The title text is in a bold, black, sans-serif font. Below the title text is a horizontal line.

# Overview of SRTM and ASTER DEM Data

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# What is SRTM?

<http://www2.jpl.nasa.gov/srtm/mission.htm>

- A c-band (5.6 cm) radar mission
- On NASA Space Shuttle Endeavour
- Completed February 2000
- 176 orbits around Earth in 11 days
- Acquired digital terrain elevation data of all land between 60°N- 56°S latitude
  - ~80% of Earth's total land mass

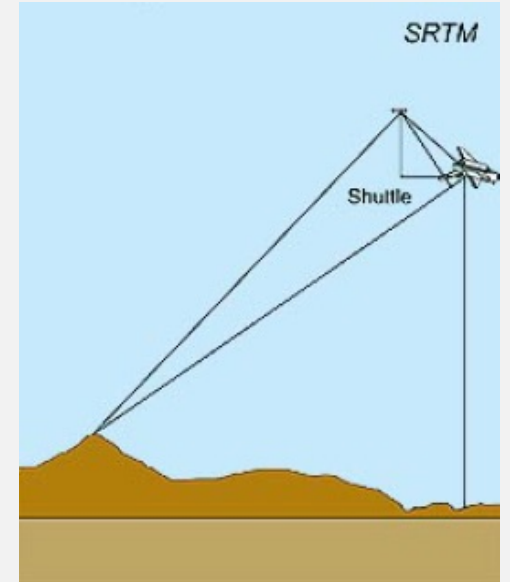
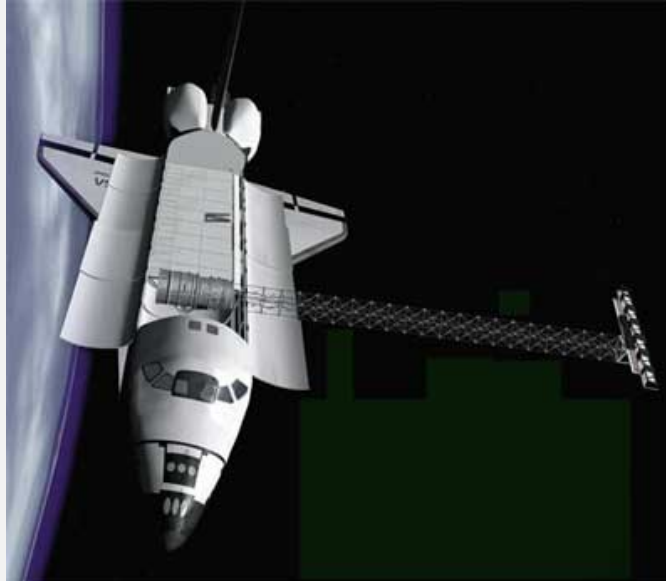
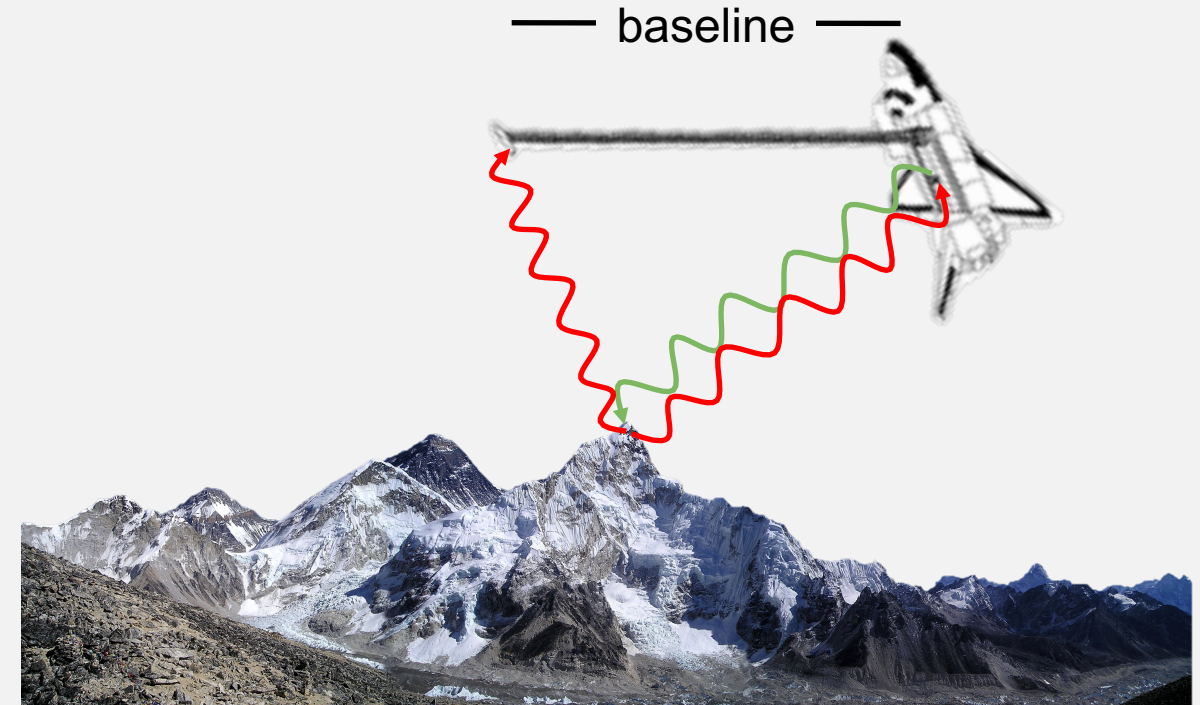


Image Credit (Right): DLR

# SRTM Digital Terrain Data

<http://www2.jpl.nasa.gov/srtm/instr.htm>

- SRTM used interferometry to gather topographic (elevation) data
- Interferometry:
  - two radar images of the same area are taken from different views
  - the difference in the two images determines the height of the surface in the digital elevation model (DEM)



~~~~~ Transmitted Wave

~~~~~ Received Wave

Radar signals being transmitted and received on the SRTM mission (not to scale)

Based on a JPL graphic: <http://www2.jpl.nasa.gov/srtm/instrumentinterferometry.html>

# NASA SRTM Version 3.0 (SRTM Plus)

- As of 2015, terrain data are available at 1 arc second or 30 m spatial resolution
- Eliminated voids in SRTM data by filling with:
  - ASTER GDEM2
  - USGS GMTED2010
  - USGS National Elevation Dataset (NED)

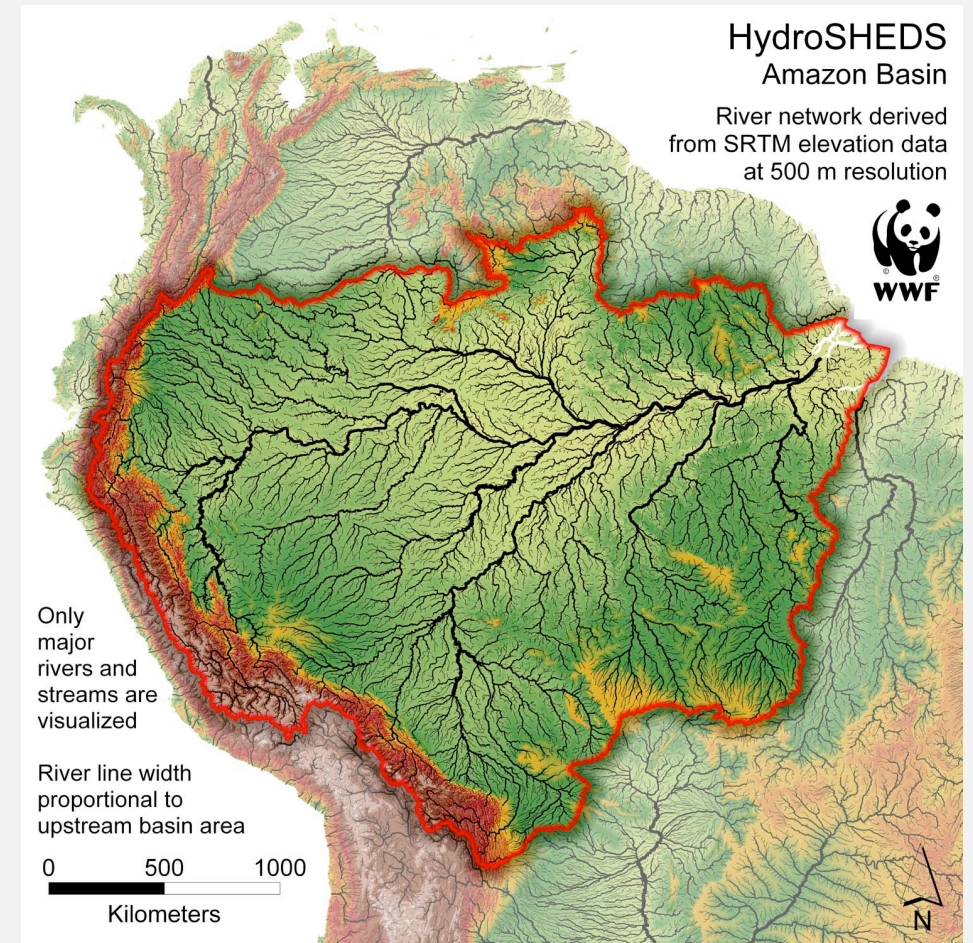


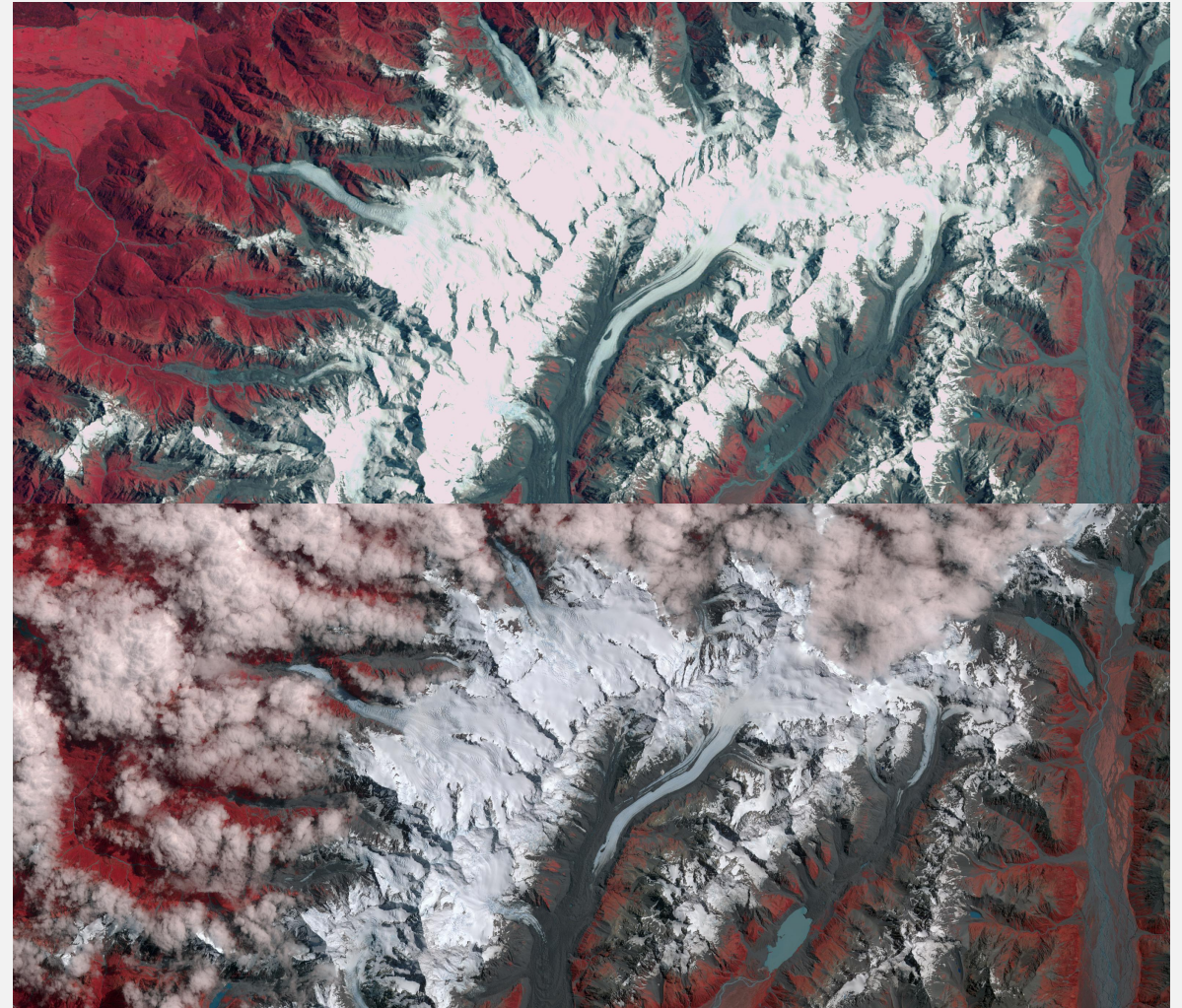
image Credit: WWF

# Advanced Spaceborne Thermal and Reflection Radiometer (ASTER)

<http://asterweb.jpl.nasa.gov/>

- Onboard Terra
  - Polar orbiting satellite launched Dec 1999
- Spatial Coverage and Resolution
  - Global
  - Swath Width: 60 km
  - Spatial Resolution Varies:
    - 15 m
    - 30 m
    - 90 m

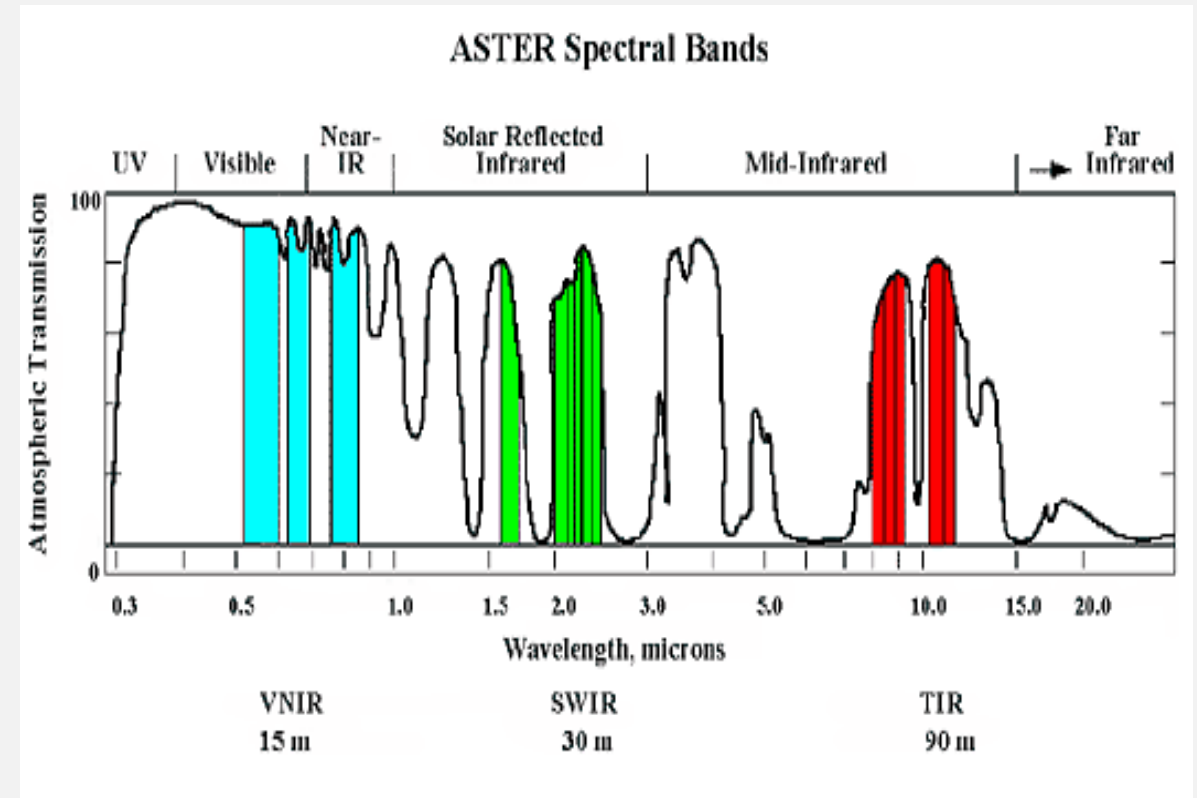
Images of New Zealand glaciers in 1990 (Landsat, top) and 2017 (ASTER, bottom)



# Advanced Spaceborne Thermal and Reflection Radiometer (ASTER)

<http://asterweb.jpl.nasa.gov/>

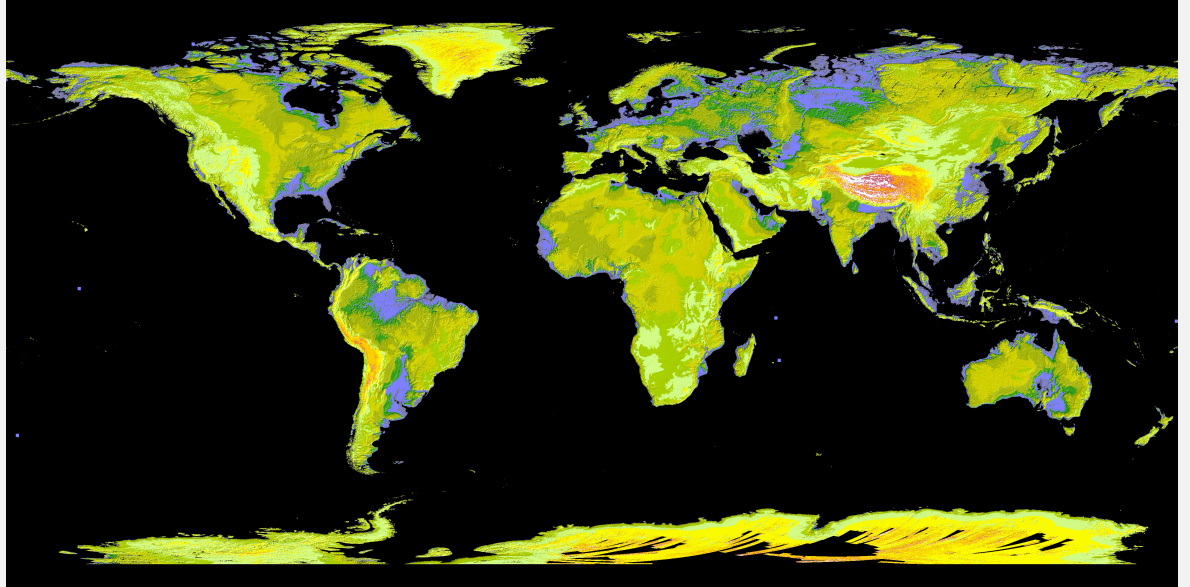
- Spectral Bands
  - **14 bands** (visible to thermal IR bands)
    - Bands 1-3: 15 m (VNIR)
    - Bands 4-9: 30 m (SWIR)
    - Bands 10-14: 90 m (TIR)
- Status alert: ASTER SWIR data acquired since Apr 2008 not usable



# ASTER Global Digital Elevation Model (GDEM V2)

<http://asterweb.jpl.nasa.gov/gdem.asp>

- A joint product developed and by NASA and the Ministry of Economy, Trade, and Industry (METI) of Japan
- Uses ASTER VNIR stereo pair images to derive DEM
- GDEM version 2 is available since 2011, based all available ASTER stereo images
- Covers land surfaces between 83°N and 83°S and is composed of 22,600 1°- by -1° tiles of 30 m resolution



# SRTM and GDEM2 Accuracy

Results from the CONUS absolute vertical accuracy assessment (in meters)

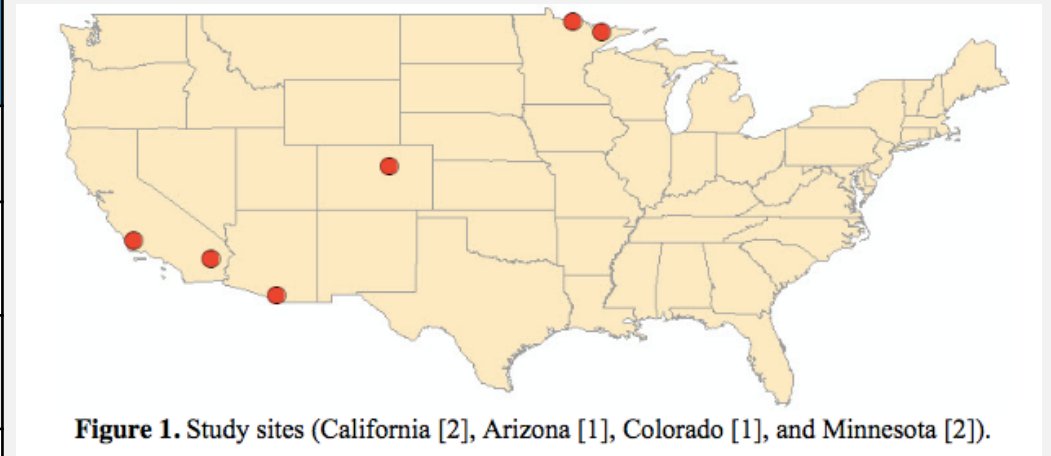
| DEM   | Minimum | Maximum | Mean  | Standard Deviation | RMSE | LE95  |
|-------|---------|---------|-------|--------------------|------|-------|
| GDEM2 | -137.37 | 64.80   | -0.20 | 8.68               | 8.68 | 17.01 |
| NED   | -46.21  | 16.42   | -0.33 | 1.81               | 1.84 | 3.61  |
| SRTM  | -28.67  | 28.58   | 0.73  | 3.95               | 4.01 | 7.86  |
| GDEM1 | -127.74 | 105.41  | -3.69 | 8.58               | 9.34 | 18.31 |

- Based on comparison with 18000 geodetic points over the U.S.
- “...the GDEM validation team recommends the release of the GDEM2 to the public, acknowledging that, while vastly improved, some artifacts still exist which could affect its utility in certain application” - ASTER GDEM team [ <https://pubs.er.usgs.gov/publication/70005960> ]

# SRTM and GDEM2 Accuracy

- DEM data accuracy depends on location and land cover categories

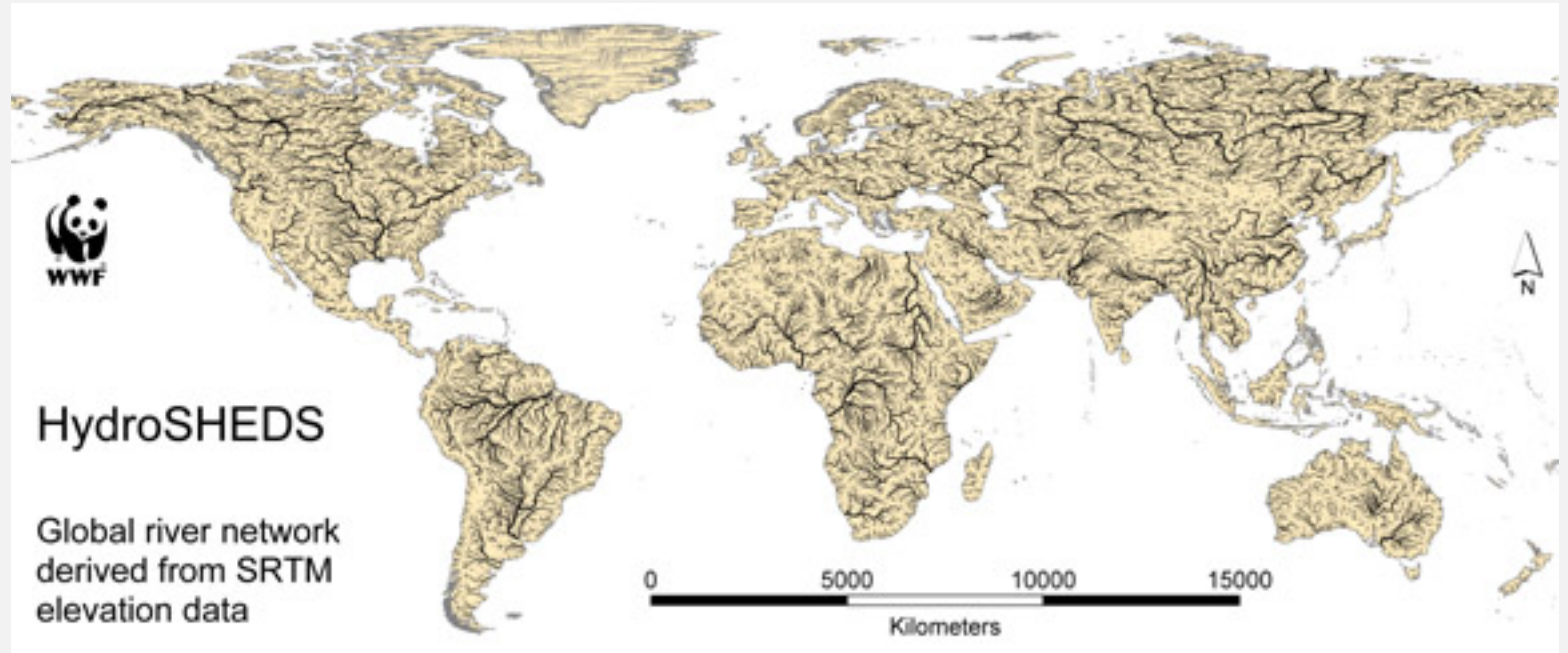
| Land Cover    | SRTM<br>(rmse m) | GDEM2<br>(rmse m) |
|---------------|------------------|-------------------|
| Grass & Shrub | 12.36            | 16.6              |
| Deciduous     | 25.49            | 20.79             |
| Evergreen     | 24.76            | 22.23             |
| Mixed         | 18.81            | 10.03             |



Tighe, M. L., & Chamberlain, D. (2009). Accuracy Comparison of the SRTM, ASTER, NED, NEXTMAP USA Digital Terrain Model Over Several USA Study Sites. In *ASPRS/MAPPS 2009 Conference Proceedings*. San Antonio, TX. Retrieved from [http://www.asprs.org/a/publications/proceedings/sanantonio09/Tighe\\_2.pdf](http://www.asprs.org/a/publications/proceedings/sanantonio09/Tighe_2.pdf)

# DEM Applications

- Useful for mapping hazardous terrain
- Calculate:
  - slope and aspect
  - catchment area
  - forest canopy height
- Models:
  - runoff
  - stream networks
  - landslides

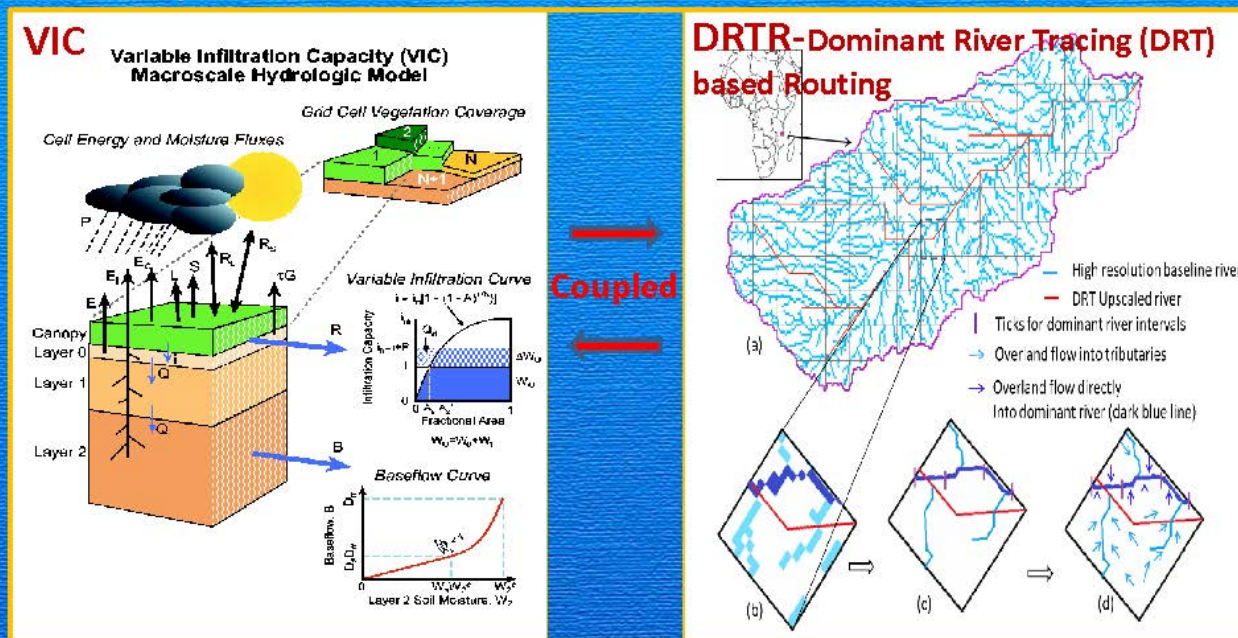


USGS HydroSHEDS

# SRTM DEM Application in Flood Modeling

## Dominant river tracing-Routing Integrated with VIC Environment (DRIVE) model

(Wu et al., 2011, 2012, 2013 *Water Resources Research*)



University of Washington

University of Maryland

**Global Flood Monitoring System (GFMS) is running quasi-globally (50°S-50°N) every three hours at 1/8<sup>th</sup> degree, and routing is also running at 1km resolution.**

The Global Flood Monitoring System (GFMS) uses HydroSHEDS\* derived from SRTM DEM is used in for identifying river networks for routing models

\* (<http://hydrosheds.org/>)

Wu et al., *Real-time Global Flood Monitoring and Forecasting using an Enhanced Land Surface Model with Satellite and NWP model based Precipitation*. GFMS. [http://flood.umd.edu/GFMS\\_conference.pdf](http://flood.umd.edu/GFMS_conference.pdf)

The background is a topographic map showing a river system. The river is dark blue and winds through a landscape of green and brown terrain. A semi-transparent white rectangular box is centered over the map, containing the title text and a horizontal line.

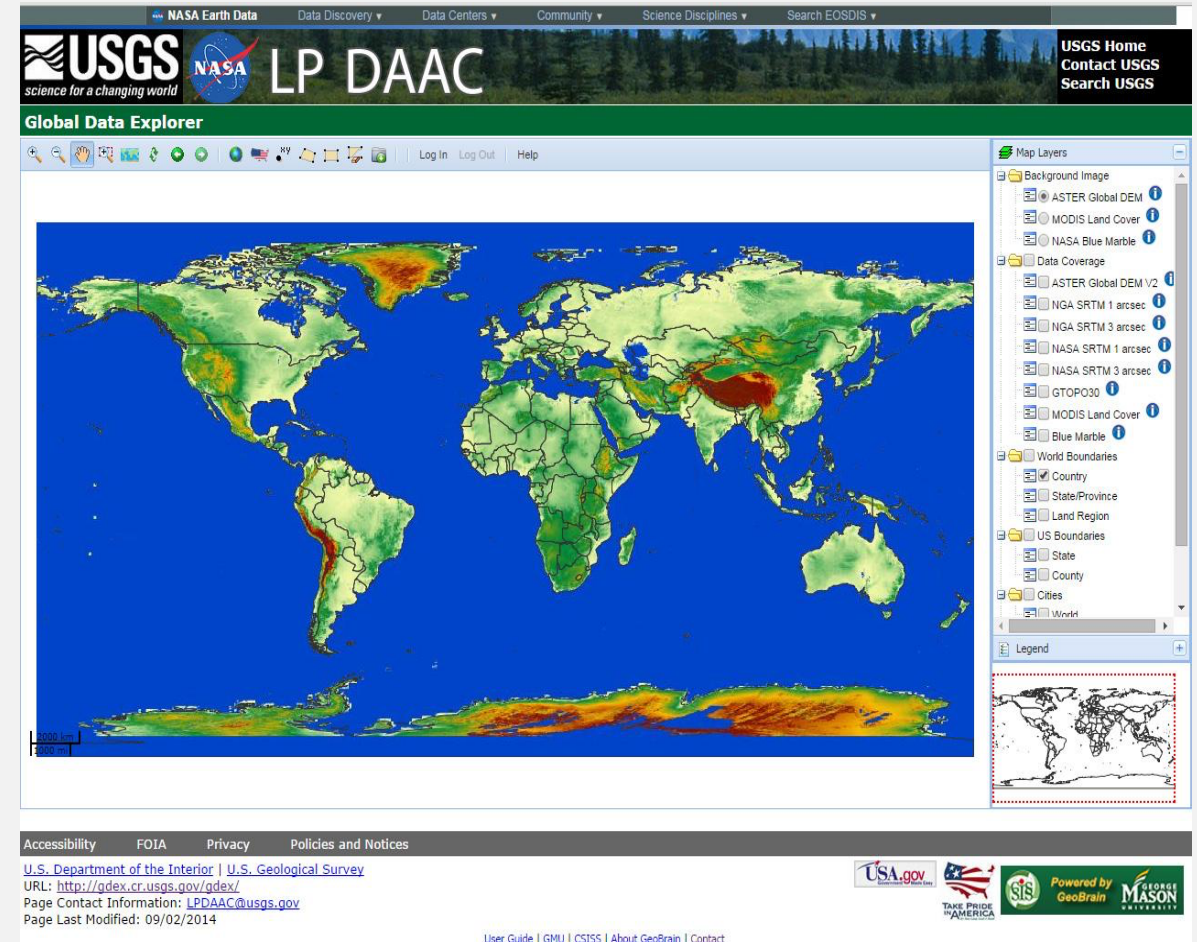
# SRTM and ASTER DEM Data Access

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# Global Data Explorer (GDEx)

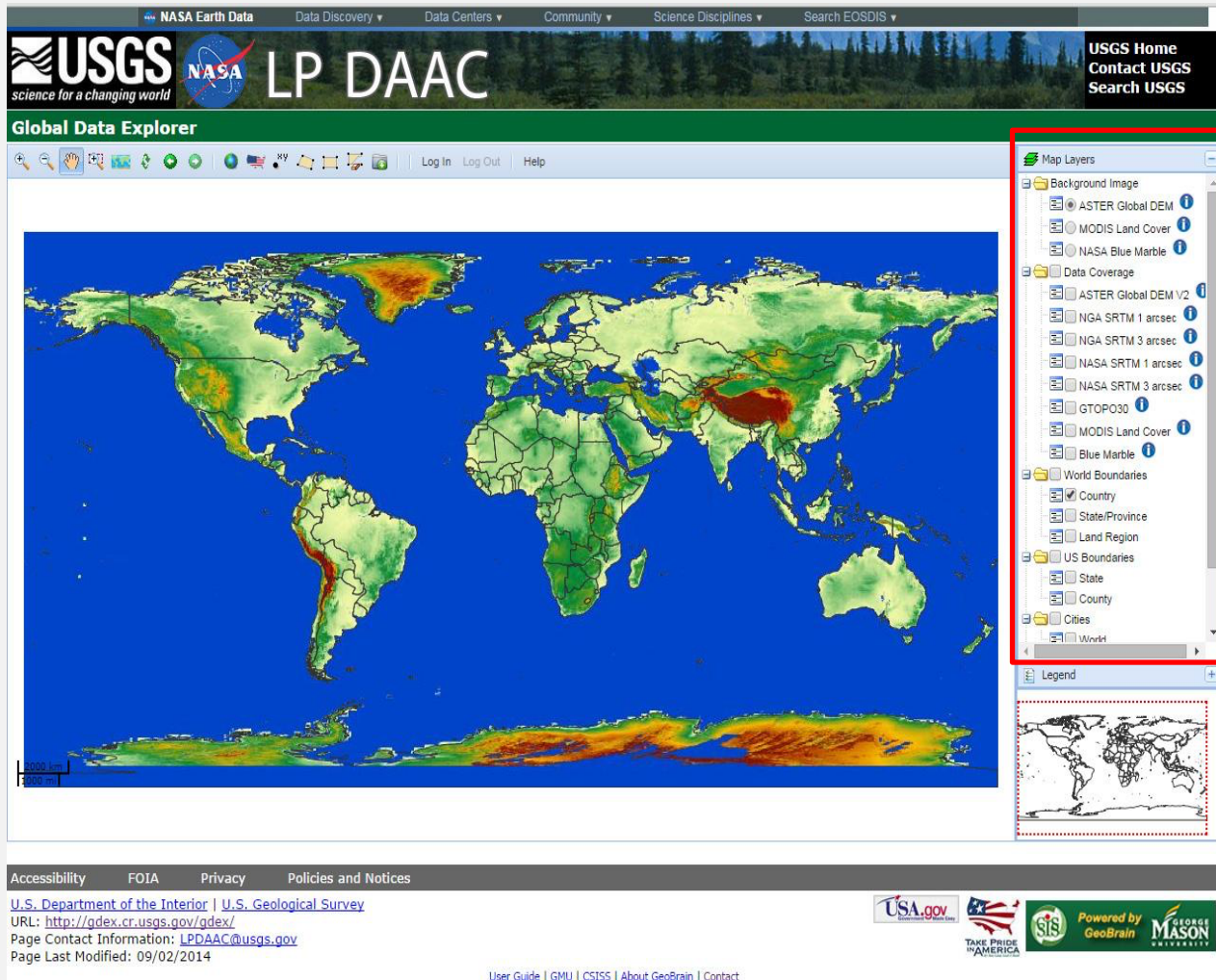
<http://gdex.cr.usgs.gov/>

- Seamless data viewer that provides access to multiple sources of digital elevation data sets
- Users can subset and download data by area of interest in multiple formats and projections
- Requires user registration via <http://urs.earthdata.nasa.gov>
- Data can be previewed before downloading

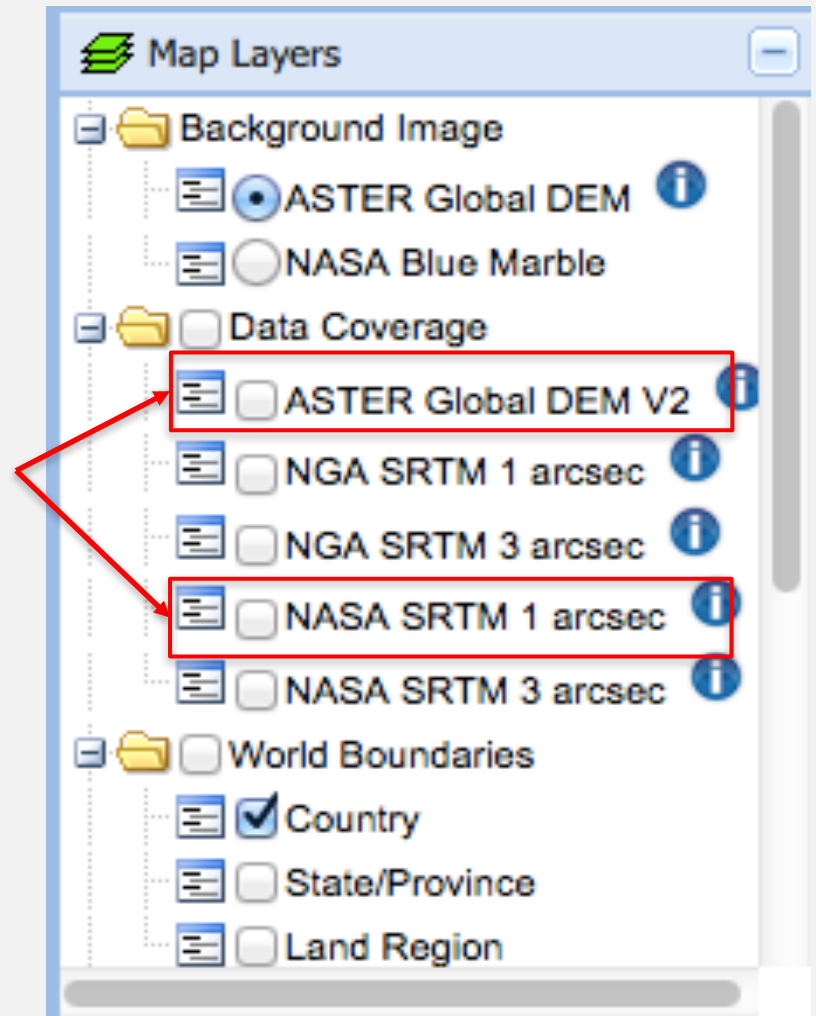


# SRTM V3 and ASTER DEM from GDEx

<http://gdex.cr.usgs.gov/>

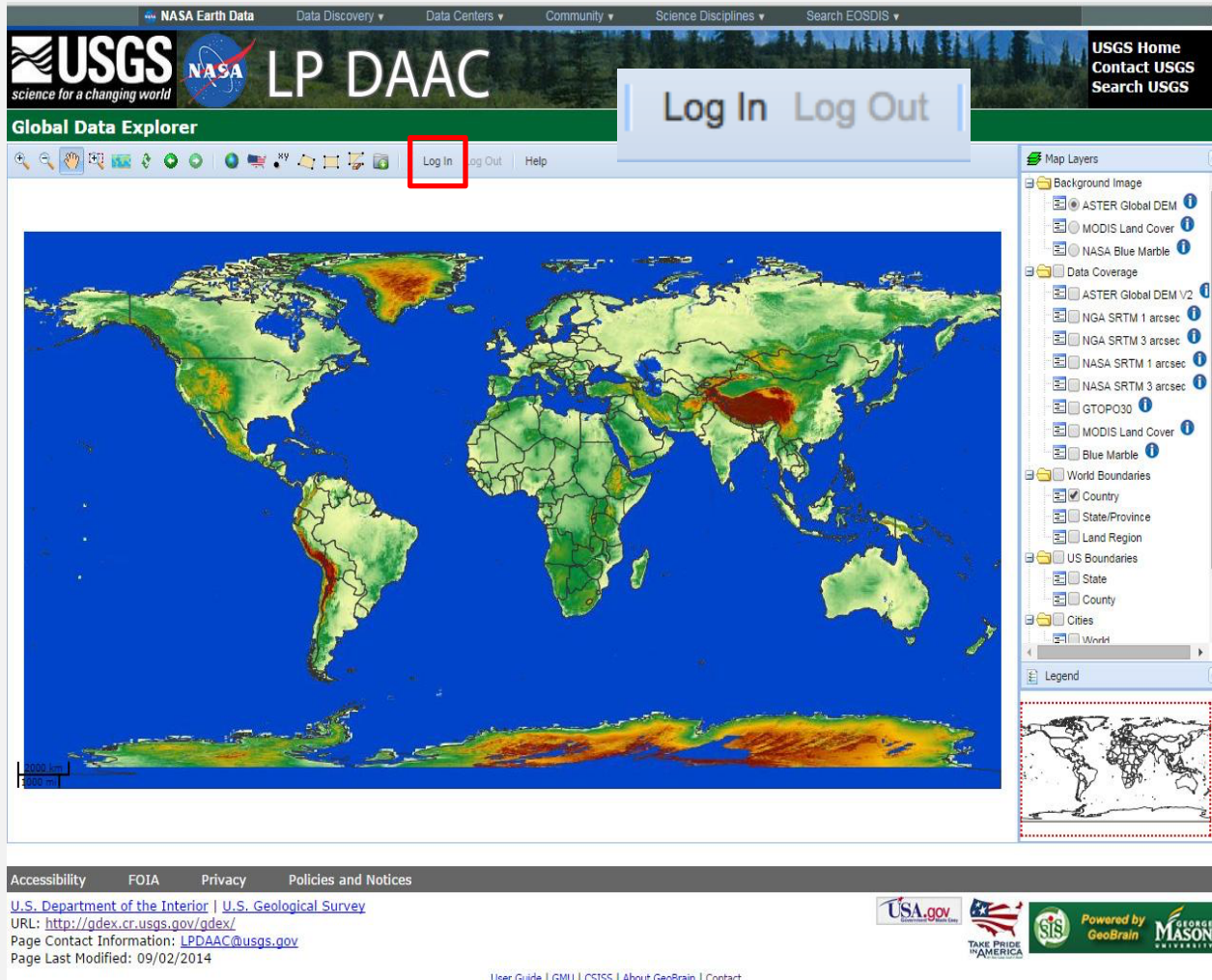


30 m  
data



# SRTM V3 and ASTER DEM from GDEx

<http://gdex.cr.usgs.gov/>



Login with your NASA Earthdata username and password

# GDEx: SRTM Data Selection

<http://gdex.cr.usgs.gov/>

The screenshot shows the GDEx SRTM Data Selection web application. The interface includes a top navigation bar with links for Data Discovery, DAACs, Community, and Science Disciplines. The main content area features a map of the United States with a bounding box tool. Annotations include:

- Download**: A button in the top right corner.
- Zoom**: A callout pointing to the zoom controls on the left side of the map.
- Define region of interest by bounding box, state, country, or lat/lon**: A large callout pointing to the bounding box tool on the map.
- Refresh**: A callout pointing to the refresh button in the top right corner.

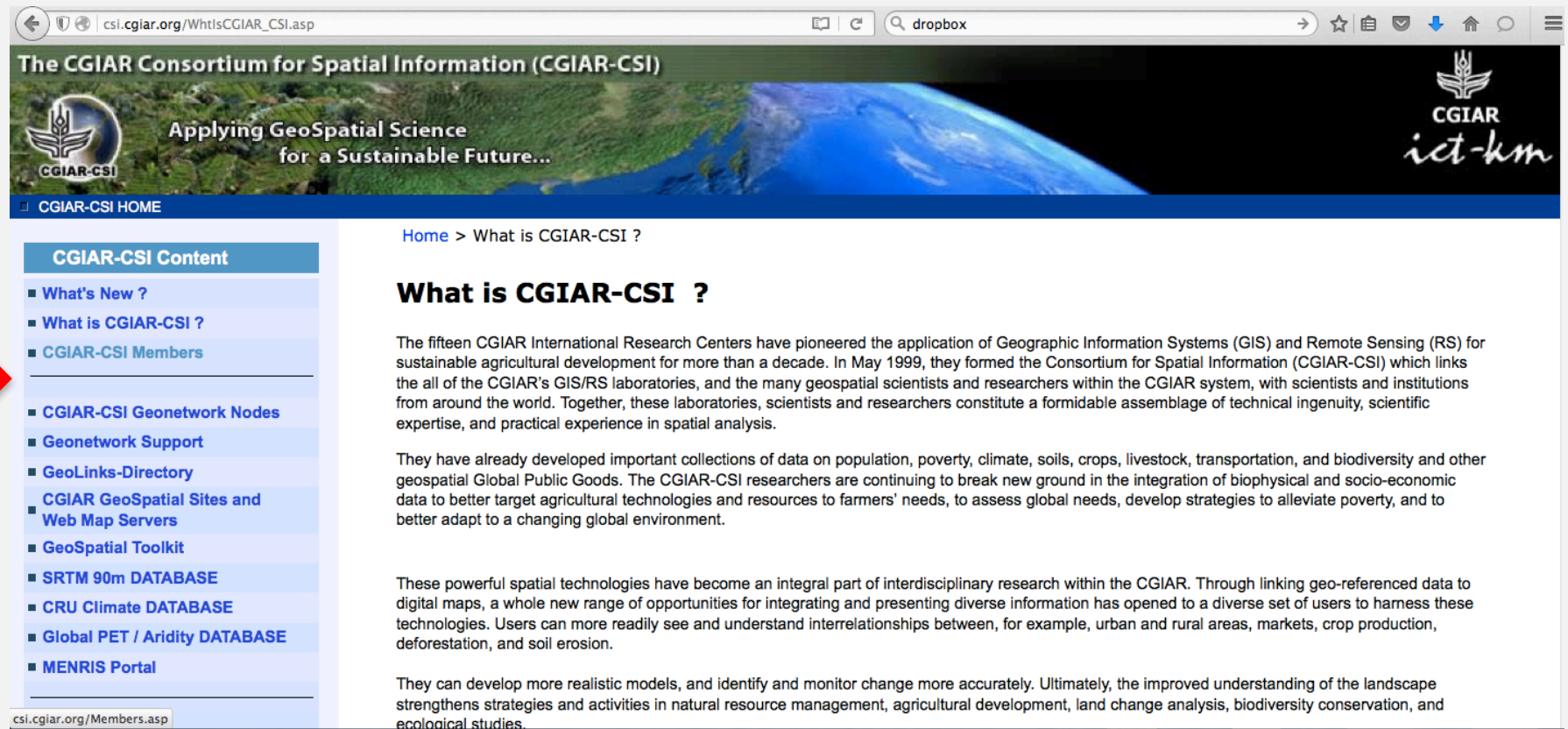
The bottom of the page contains links for Accessibility, FOIA, Privacy, and Policies and Notices, along with contact information for the U.S. Department of the Interior and U.S. Geological Survey.

# SRTM Data from CGIAR-CSI

[http://csi.cgiar.org/WhatisCGIAR\\_CSI.asp](http://csi.cgiar.org/WhatisCGIAR_CSI.asp)

## CGIAR-CSI: Consultative Group for International Agricultural Research Consortium of Spatial Information

SRTM data  
(90 m)



# CGIAR-CSI: SRTM Data Access

Click to  
select and  
download  
data



The CGIAR Consortium for Spatial Information (CGIAR-CSI)

Applying GeoSpatial Science  
for a Sustainable Future...

CGIAR-CSI HOME ■ SRTM 90m DATABASE HOME ■ DISCLAIMER ■ HELP

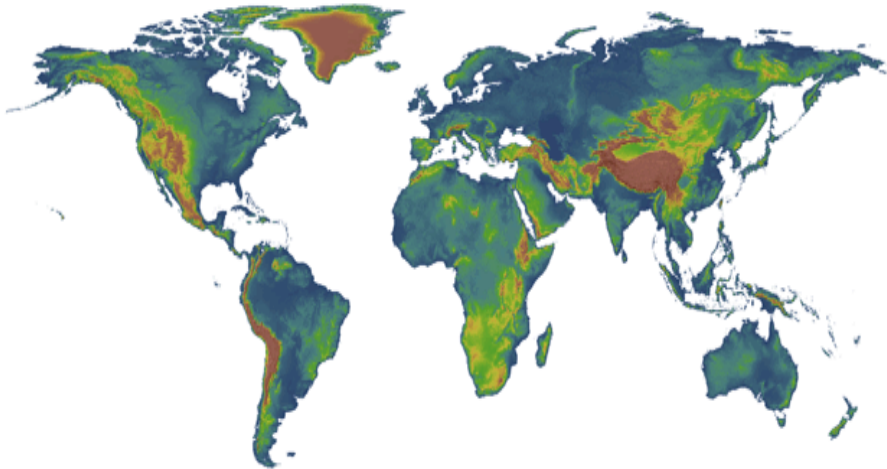
**CGIAR-CSI Content**

- What is CGIAR-CSI ?
- CGIAR-CSI Members
- What's New ?
- CRU Climate Data

**SRTM Content**

- **SRTM Data Search and Download**
- SRTM Data Processing Methodology
- SRTM FAQ
- SRTM Quality Assessment (PDF File - 2.55 Mb)
- About SRTM Imagery
- CIAT Landuse Project
- How to Search for Data?
- Disclaimer
- Contact Us

**SRTM 90m Digital Elevation Data**



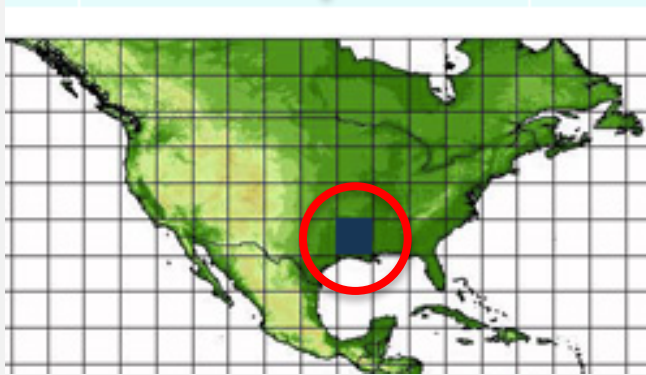
**new** Resampled SRTM data to 250m resolutions for the entire globe are available <https://hc.box.net/shared/1yidaheouv> (Password: ThanksCSII)

**UPDATE - VERSION 4:** THE SRTM DATA NOW AVAILABLE FROM THIS SITE HAS BEEN UPGRADED TO VERSION 4. THIS LATEST VERSION REPRESENTS A SIGNIFICANT IMPROVEMENT FROM PREVIOUS VERSIONS, USING NEW INTERPOLATION ALGORITHMS AND BETTER AUXILIARY DEMs. WE ARE CONFIDENT THIS IS NOW THE HIGHEST QUALITY SRTM DATASET AVAILABLE

# CGIAR-CSI: SRRTM Data Selection

## Spatial selection can be by lat/lon

**or** by clicking on the  
grid(s)



SRTM Data Selection Options

Chinese users : [中国用户可通过中国科学院镜像站点下载](#)

1. Select Server:

☒ CGIAR-CSI (USA)☐ HarvestChoice (USA)☐ JRC (IT)☐ King's College (UK)☐ TelaScience (USA)

2. Data selection method:

☒ Multiple Selection☐ Enable Mouse Drag☐ Input Coordinates

Many tiles can be selected at random locations. These selected tiles are listed in the results page for download.

☐ Decimal Degrees (ie 34.5, -100.5)☒ Degrees: Minutes: Seconds

Longitude - min: max: Longitude - min: max: East West

Latitude - min: max: Latitude - min: max: North South

Longitude: 100.00 Latitude: 100.0 Tile X: 10 Tile Y: 10Mark AreaClear Area

3. Select File Format:

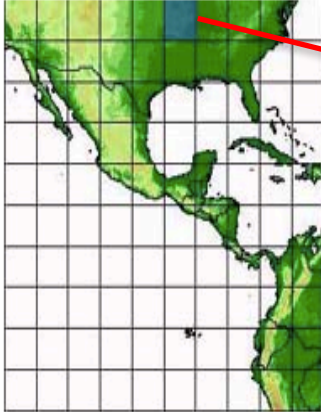
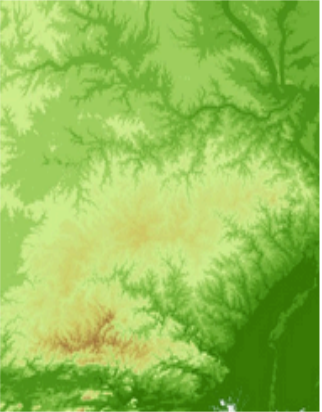
☒ GeoTiff☐ ArcInfo ASCII

Click here to Begin Search >>

Select data format

A world map with a green-to-brown color scale representing elevation. A black grid is overlaid on the map, with latitude and longitude coordinates labeled along the edges. The grid covers the entire visible area of the map, from approximately 10°N to 72°S latitude and 1°E to 72°W longitude.

# CGIAR-CSI: SRTM Data Download

| Description   | Location  | Image   |
|---|---|---|
| <p><b>Product :</b> SRTM 90m DEM version 4</p> <p><b>Data File Name :</b> srtm_18_05.zip</p> <p><b>Mask File Name:</b> srtm_mk_18_05.zip</p> <p><b>Latitude min:</b> 35 N <b>max:</b> 40 N</p> <p><b>Longitude min:</b> 95 W <b>max:</b> 90 W</p> <p><b>Center point :</b> Latitude 37.50 N<br/>Longitude 92.50 W</p> |  |  |

CSI Server :  [Data Download \(FTP\)](#)  [Data Download \(HTTP\)](#)  [Data Mask Download \(FTP\)](#)  [Data Mask Download \(HTTP\)](#) [^TOP^](#)

- Download options
- Digital elevation data can be downloaded as GeoTIFF

## GDEx and CGIAR-CSI

- Both tools are easy to use with spatial subsetting
- Data can be downloaded as GeoTIFF to import in GIS
- GDEx SRTM is 30 m whereas CGIAR-CSI is 90 m
- CGIAR-CSI provides combined multiple tiles whereas GDEx provides a series of individual tiles
- GDEx also provides access to ASTER GDEM2 and other DEM data
- GDEx requires user registration and login through **NASA Earthdata**

The background is a topographic map showing a river system. The river is dark blue and winds through a landscape of green and brown hills. A semi-transparent white rectangular box is overlaid on the map, containing the text "Next Demonstration of GDEx".

Next  
Demonstration of GDEx

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